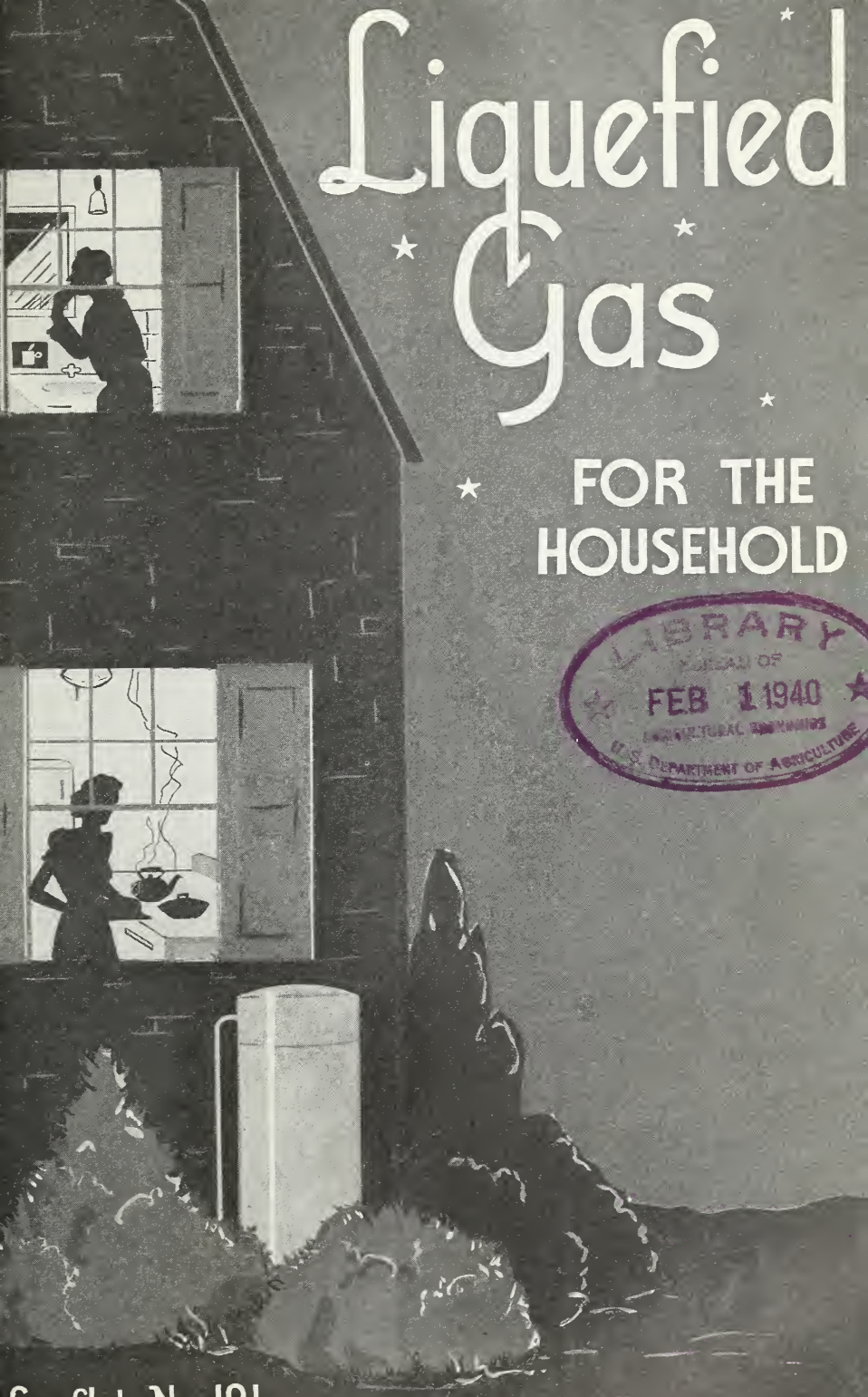
Liquefied Gas

FOR THE HOUSEHOLD



Leaflet No. 191
U.S. DEPARTMENT OF AGRICULTURE

LIQUEFIED GAS FOR THE HOUSEHOLD

By A. H. Senner, *mechanical engineer, Division of Structures, Bureau of Agricultural Chemistry and Engineering,*[1] and Helen S. Holbrook, *household equipment specialist, Household Equipment Division, Bureau of Home Economics*

Description and Sources of Liquefied Gas

Liquefied gas includes propane and butane, or mixtures thereof, delivered in liquid form in heavy cylinders or tanks to the customer's premises and made available for use in gaseous form.

Commercial propane and butane have their principal origin, so far as the uses herein discussed are concerned, in the natural gasoline obtained from the "wet" natural gas as it issues from the wells in the gas fields, the most important of which are in Oklahoma, Texas, and California. The lightest, or what might be termed the most gaseous, part of natural gasoline is propane, and the next lightest is butane. Some propane and butane are also obtained from refineries. Propane and butane can be transported as liquids under pressure.

A question frequently asked is: What is the available reserve supply of liquefied gas, or what is the probability of a shortage in this type of fuel? The Department of Agriculture is not in a position to answer this question, but it appears that the reserve is more than adequate to dispel any fear of sudden cessation of supply in the near future.

Methods of Distributing and Measuring Liquefied Gas

There are several different methods of distributing liquefied gas. The most widely used requires the installation of two cylinders. When one cylinder is exhausted the user shuts off the empty cylinder and opens the valve connecting the full cylinder with the house supply line. He then orders from the distributor a replacement for the empty cylinder (fig. 1). Sometimes much smaller cylinders are used, the user taking delivery at the dealer's place of business, thus eliminating delivery expense. A change-over device is sometimes employed which automatically connects the house supply line with the reserve cylinder when the first cylinder has been emptied.

Another method of distribution involves the use of permanent above-ground or below-ground storage, of varying capacities, on the user's premises (fig. 2), with periodic deliveries to this storage by means of tank trucks. The amount of gas stored on the user's premises is sufficient to last longer than the period between scheduled deliveries. If the storage cylinder is located above ground the monthly consumption is sometimes metered, and sometimes determined by means of weighing the cylinder. If storage is underground a meter is always employed.

[1] Acknowledgment is made of the assistance rendered by C. O. Newman, laboratory assistant, Bureau of Agricultural Engineering.

Acknowledgment is also made of the cooperation of the Johns Hopkins School of Engineering in making available the laboratories in which part of the investigation was conducted.

Issued December 1939

Liquefied Gas for Cooking

Laboratory studies made by the Department of Agriculture indicate that the most economical results can generally be obtained by the use of specially designed equipment for liquefied gas. It is not possible to get satisfactory results with an unaltered manufactured-gas type of cooking range, water heater, or space heater. The efficiencies of ranges for using liquefied gas were found to be higher than those commonly used for manufactured and natural gas.

FIGURE 1.—Two-drum liquefied gas installation.

To determine operating characteristics and comparative costs, the Bureau of Home Economics selected menus which involved typical cooking processes and conducted a series of tests on ranges using liquefied gas, electricity, kerosene, and gasoline. Where quality differences were distinguishable, the finished product was passed on by four or five judges, and records were kept as to the general quality of the cooked food. An attempt was made to determine quality differences due to the fuel rather than to the stove design, except as stove design was limited by the fuel. In general the best

baking and frying results were obtained on the gas and electric ranges. The poorest baking results were obtained in the kerosene and gasoline ovens which had no thermostatic control and whose temperature indicators were incorrectly placed to indicate the true oven temperature. The time needed for the cooking process was carefully kept for each item involved in the menu, but only the fuel consumption needed for the meal as a whole was determined. For several items there was more variation in time between two stoves using the same fuel than in the average time for the different fuels.

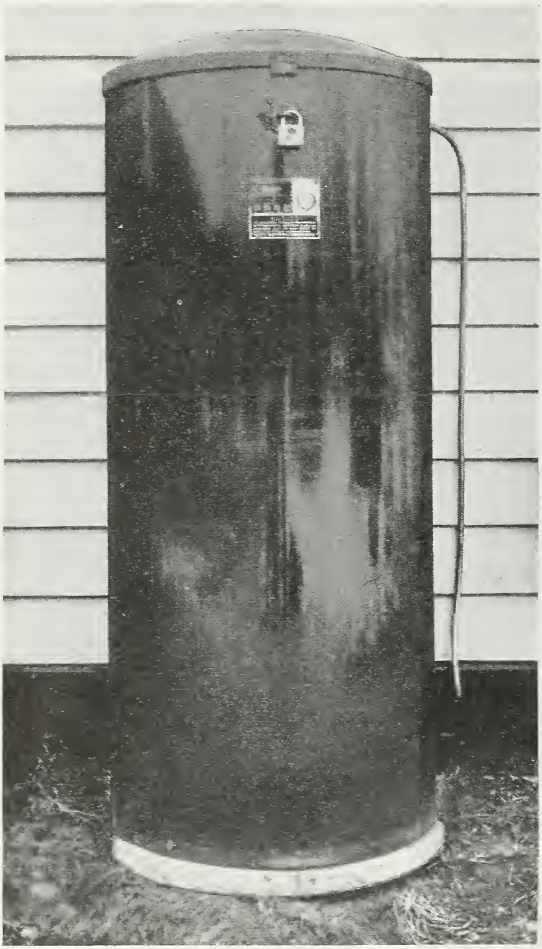


FIGURE 2.—Single-cylinder liquefied gas installation.

On an average, the time needed on the liquefied gas stoves to do the same cooking was 88 percent of the time required on the electric stoves, 92 percent of that required on the kerosene stoves, and 94 percent of that required on the gasoline stoves. The fuel consumed in cooking the same meals on the various stoves used in these tests indicated that 100 pounds of propane gas used for cooking would be the equivalent, respectively, of about 350 kilowatt hours of electricity, 25 gallons of kerosene, or 27 gallons of gasoline.

Comparative Costs

Many factors besides the rates charged in a given locality for the fuel affect the costs, such as (1) the skill with which the range is handled, (2) the amount of cooking done in the so-called insulated cookers or cooker wells with which some ranges are equipped, (3) the relative amount of oven and top-burner cooking, (4) the amount of use of auxiliary equipment such as wood- or coal-burning stoves, electric toasters, percolators, etc., and (5) variation in efficiency with use. Liquefied gas and electricity are relatively high in cost as compared with gasoline and kerosene at average

prices. Depending upon conditions of usage, etc., liquefied-gas costs for cooking when performing the cooking tasks represented by the test meals may be considered approximately equal to those of electricity when electric current costs 3 cents per kilowatt-hour and liquefied gas costs 10 cents per pound. Liquefied gas at 10 cents per pound costs four times as much as kerosene at 10 cents per gallon, and 3¾ times as much as gasoline at 10 cents per gallon. However, variations in practice may change comparative figures as much as 10 or 15 percent.

For costs of gas and electricity other than those given above, proportional adjustments must be made. For example, electricity at 2 cents per kilowatt-hour would be approximately equal to liquefied gas at 6⅔ cents per pound, subject, as before stated, to variation of 10 or 15 percent, depending upon the difference between conditions of actual usage and those prevailing during the Department tests.

It cannot be emphasized too strongly that the bare fuel costs do not necessarily represent a true comparative cooking cost. For instance, one manufacturer of kerosene cook stoves recommends the replacement of kindlers once a month. Thus, if four kindlers are replaced per month at a cost of 10 cents each this represents an expenditure of 40 cents monthly that should be added to the fuel cost. Also the kerosene and gasoline ranges have admittedly higher depreciation rates than the average liquefied-gas range, and this also represents an additional cost item offsetting some of the difference in fuel costs.

For water heating, liquefied gas at 8 cents per pound costs slightly less than electricity at 2 cents per kilowatt-hour, and about 4½ times as much as kerosene at 10 cents per gallon.

Convenience

There is little doubt that the gas and the electric ranges are the most convenient types. In the matter of starting, electricity and liquefied gas require no special knowledge or manipulation. The mere lighting of the gas with a match is all that is necessary in the case of liquefied gas; in fact, the modern range surface burners are commonly lighted by means of a continuously operating pilot burner, necessitating only the opening of a gas valve. In the adjustment of the amount of heat desired, the gas ranges provide a much wider and finer adjustment than is possible with any of the other types of ranges discussed.

Variation of the intensity of heat in an electric range is effected by means of a switch usually having three steps, high heat, medium heat, and low heat. A recent improvement provides two additional heat positions, and brings the flexibility of the electric range closer to that of the gas range.

Kerosene stoves require more care both in lighting and in adjusting the burner. The wick-type burner is probably the more convenient to operate. The wickless type is rather more difficult to light and to adjust for varying degrees of heat and sometimes goes out when the flame is being reduced to low intensity. Considerable attention is required to keep the wicks, in the case of the wick type, and kindlers, in the case of the wickless type, in good condition to assure ease in operation and freedom from odors.

In a gasoline range, it is first necessary to light a generator burner and carefully adjust it before lighting either the surface burners or the oven burner. As the gasoline range operates by means of pressure maintained in the fuel storage tank on the range, attention must be given to maintaining proper operating pressure at all times.

The thermostatic control of the oven burners, now feasible only with electricity and manufactured, natural, or liquefied gas, is a great aid in maintaining proper oven temperatures during the cooking process. The thermostat furnished with this type of range when properly set provides good reliable control and can be adjusted very closely to maintain values indicated. On the other hand the temperature indicators on the kerosene and gasoline ranges considered in the tests covered in this study proved to be of little value, since they in no case represented the true oven temperature, primarily because of their location.

Cleanliness

The electric range is the cleanest of the several types tested, and the gas range is next. Because of the fact that water vapor is a product of combustion of the gases used as fuel and because the combination of this water vapor and the oils and fats given off in the cooking process forms a greasy film, gas ranges need somewhat more care than electric ranges. This greasy film may be noticed around parts of the stoves such as the gas cocks, which are cleaned less frequently than the flat enamel surfaces.

Initial Costs

There is, in general, no installation cost involved in the purchase of a gasoline or kerosene cooking range. The installation costs for liquefied gas equipment vary somewhat throughout the country. In the vicinity of the District of Columbia in 1938 such costs were approximately $10. Sometimes the cost of the electric-range installation is not charged directly to the consumer, but is absorbed in whole or in part by the electric company. The average wiring cost for a range installation by one of the larger public utilities of Maryland in 1938 was about $30 for service and circuit runs not exceeding 75 feet.

Wickless types of kerosene ranges with three top burners and an oven vary from about $50 or less, to $100, whereas the wick types for the same general designs vary from about $75 to $110. Similar ranges in prices prevail for gasoline stoves.

Liquefied-gas ranges are offered as low as approximately $40 for models having oven, broiler, and four top burners. Other models giving greater cooking capacities, improved finish, and automatic-control features cost as much as two or three hundred dollars. Similarly, electric ranges are offered at prices ranging from approximately sixty-five to two or three hundred dollars, depending upon the size, the style and quality of finish, and the automatic features desired by the purchaser.

Water Heating

Heaters using liquefied gas are similar in general principle and appearance to those offered for use with natural and manufactured gas

and are of the three following classes: (1) Manually controlled, (2) automatic heaters of the instantaneous type, and (3) automatic heaters of the storage type.

The choice between the instantaneous and storage types of automatic water heaters depends on several factors, and the experienced water-heater distributor can generally tell from an analysis of the user's requirements which type is best adapted. Figure 3 shows a modern full-automatic storage heater.

Refrigeration

In recent years flames produced by kerosene and manufactured, natural, or liquefied gases have been used very satisfactorily for the operation of domestic refrigerators. Except for burner details the liquefied-gas refrigerator is the same as the refrigerators operated by manufactured or natural gas. It is fully automatic in operation, is simple in design, and has no moving parts. It is used frequently where the price of liquefied gas is more favorable than that of electricity, or where the purchaser prefers the gas refrigerator.

Safety [2]

The liquefied gases discussed in this leaflet present a hazard comparable to any flammable natural or manufactured gas, except that being heavier than air, in certain types of installations ventilation requires added attention. Some of the liquefied gases have been odorized so that their presence can be readily detected. The use of such an odorant should be considered essential.

Commendable work has been done by the Underwriters' Laboratories, and municipal, State, and national fire-protection associations on designing proper containers for the gases, as well as on the system for conducting the gases from the storage cylinders or tanks to points of consumption within the household. The matter of proper location of buried and above-ground storage cylinders and their safe distances from openings through which gas might leak into buildings has also been given considerable study. Authorized dealers in liquefied-gas equipment are usually familiar with and follow such mandates. In general, installations made by such organizations are well within the limits of safety prescribed by the safety and fire-prevention organizations referred to above. It might be well, nevertheless, to request information from the Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill., for standards of installation, etc., for the type of fuel under consideration and to be certain that proper safety precautions are being observed.

Since liquefied gases are heavier than air, care should be used not to locate such equipment as water heaters in poorly ventilated spaces, since under such conditions a leak from a water heater might result in a dangerous accumulation and possible explosion of gas.

The American Gas Association, of Cleveland, Ohio, is giving attention to the perfecting of liquefied-gas equipment. The stamp of

[2] See Farmers' Bulletins 1643, Fire Safeguards for the Farm, and 1678, Safe Use and Storage of Gasoline and Kerosene on the Farm.

approval of that association on a piece of equipment indicates that it has passed tests of safety and performance requirements for a particular fuel, as, for example, propane. Only the fuel for which the equipment has been tested should be used. Every stage in the handling of liquefied gases is receiving its share of safety study. For example, tank trucks for the distribution or transfer of such gases are being thoroughly safeguarded in respect to design, construction, and operation. Containers for liquefied gases used in interstate shipments must meet exacting requirements stipulated by the Federal Government.

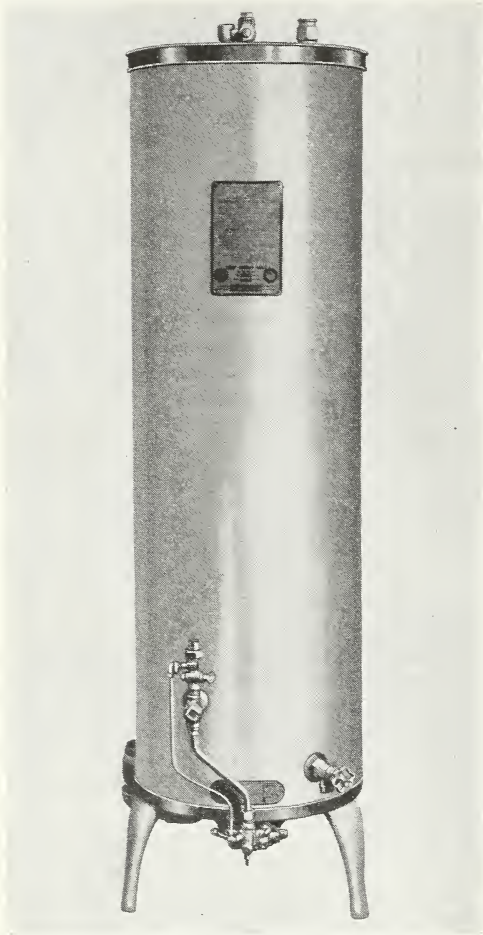


FIGURE 3.—An automatic liquefied-gas storage-type water heater.

In order to comply with the regulations of the National Board of Fire Underwriters applying to domestic installations, the cylinders or drums and control equipment must be installed outside of buildings, well removed from all openings whereby escaping gas may enter or accumulate within the building.

Piping inside a building must be installed with great care in an approved manner, suitable joint compounds being used in order to minimize the chance of leakage.

The authorized distributors' instructions for safe and efficient use of the gas should be followed, unless such recommendations are less rigorous than those of the national or local agencies. In such cases the safer recommendations should be followed. Reputable producers and distributors, however, are eager to promote safety in the use of their fuels.

164243°—39

U. S. GOVERNMENT PRINTING OFFICE: 1939

For sale by the Superintendent of Documents, Washington, D. C. - - - - - Price 5 cents